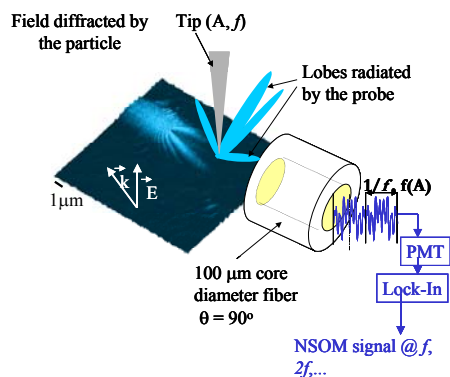


## Apertureless Near-Field Scanning Optical Microscopy

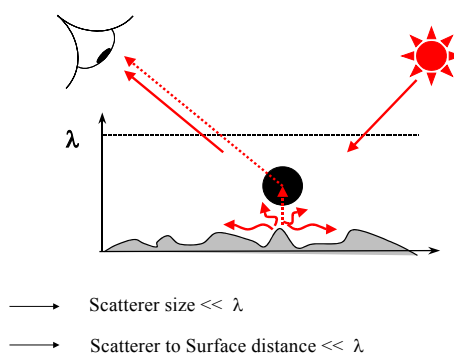
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Metallic nanoparticles are of interest for various optical based studies, including surface enhanced Raman spectroscopy, single molecule spectroscopy, chemical sensors, photonic bandgap structures, etc. Their ability to show dramatic local field enhancement of the incident electromagnetic field due to the coherent resonant electron plasma excitation, as well as the sensitivity of this behavior to the particle shape and surrounding physico-chemical properties, make them particularly well suited for many of these applications. While most studies are performed using conventional far-field set-ups, the fundamental interactions occur in the vicinity of the particles and are therefore governed by the near-field response of the particles. To gain an understanding of these interactions, we are developing time-resolved and CW near-field scanning optical microscopy (NSOM) capabilities in our laboratory. This technique has begun to be developed in the past ten years to overcome the spatial resolution limits of conventional optical microscopes. They also represent a unique way to study the near-field response (diffraction pattern) of objects and consequently to understand the interactions between objects and fields at this scale.

We are focusing on “apertureless” NSOM, the principle of which is illustrated in Figure 1. The illuminated sample surface generates two kinds of optical fields: a propagating field related to object details greater than the illuminating wavelength( $\lambda$ ) and a confined (evanescent) field which contains sub-wavelength information. To detect this evanescent field, a nanometric sized probe is immersed in the optical near-field zone of the sample surface. The particle scatters the near-field photons into propagating waves that can then be detected.



**Figure 2.** NSOM signal of an isolated silver nanoparticle illuminated at the plasmon resonance.



**Figure 1.** Principle of near-field optics.

By both scanning the probe (such as an afm tip) above the surface and detecting the probe/sample interaction at each point of this plane we obtain a local map of the near-field intensity. Figure 2 illustrates the unusual NSOM signal of the diffracted field of a silver nanoparticle placed on an optical slab. The nanoparticle has a 40 nm diameter and is illuminated at 404 nm. The nature of the scattered field is predicted theoretically, and is expected to influence the means through which material excitations can be harnessed for telecommunications and computing applications.

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